

BELLCOMM, INC.
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SUBJECT: AAP System Simplifications Resulting
From Decoupling The ATM From The
Cluster - Case 620

DATE: December 5, 1968
FROM: W. W. Hough

MEMORANDUM FOR FILE

A brief investigation has demonstrated that significant savings in AAP flight hardware, and therefore in cost, could be realized by implementing only the CM-SM/ATM decoupled mission. The converse is not true; if capability for a coupled ATM mission is implemented, deletion of backup decoupled mission capability would result in very minor simplifications.

When all equipment not required for a decoupled mission is deleted from the baseline LM-A, little sophisticated hardware remains. Most of what does remain is in fact new or modified AAP equipment, and not basic Apollo LM equipment. The possibility of replacing the LM-A as the ATM support module with an MDA derivative* (tentatively called the Big Dumb Module, or BDM) then deserves consideration because of:

1. Cost savings resulting from MSFC in-house design and fabrication of the BDM.
2. Increased internal volume and stowage capability.
3. Increased mission duration capability (from 28 to 42 days).
4. A LM Ascent Stage is preserved for a future lunar application.

Simplifications to the AAP-3 CM-SM and the MDA resulting from deletion of the unmanned LM-A rendezvous and docking requirement are significant. Some baseline mods to the Block II CM-SM do not have to be made to support a decoupled mission. There are fewer modifications required in the case of the 28-day LM/ATM mission than in the case of the 42-day BDM/ATM mission. However, it is not clear that saving CM-SM hardware will result in a net cost saving, as two AAP CM-SM configurations would have to be developed. There are other potential savings in the ATM, the SLA, and in mission planning, crew training, MCC-H software, and systems test that result if only decoupled mission capability is implemented.

(NASA-CR-103912) AAP SYSTEM SIMPLIFICATIONS
RESULTING FROM DECOUPLING THE ATM FROM THE
CLUSTER (Bellcomm, Inc.) 17 p

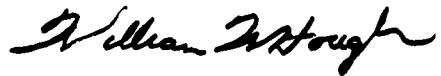
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This study was performed in support of the current ML cost-reduction exercise, and the results were presented to the Deputy Director of AAP, Mr. Disher, and other member of the ML staff on November 27. Copies of the charts used in that presentation are attached.



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W. W. Hough

Attachments

DECOPLE ATM FROM CLUSTER

- I. LM-A VS BDM (BIG DUMB MODULE)
 - A. SIMPLIFICATIONS TO LM-A
 1. SAVINGS IN AAP MODS
 2. APOLLO EQUIPMENT NOT REQUIRED
 - B. FUNCTIONS RETAINED IN LM-A TO SUPPORT DECOUPLED ATM EQUAL BASELINE LM-A MINUS SIMPLIFICATIONS
 - C. FUNCTIONS REQUIRED IN BDM EQUAL FUNCTIONS RETAINED IN LM-A
- II. SIMPLIFICATIONS TO OTHER MODULES
 - A. AAP-3 CM-SM
 1. ELIMINATION OF UNMANNED RENDEZVOUS AND DOCKING
 2. POSSIBLE SIMPLIFICATIONS DUE TO CHANGE FROM 56 DAY COUPLED MISSION TO
 - a. 28 DAY DECOUPLED MISSION WITH LM-A/ATM
 - b. 42 DAY DECOUPLED MISSION WITH BDM/ATM
 - B. MDA
 1. ELIMINATION OF UNMANNED RENDEZVOUS AND DOCKING
 2. ELIMINATION OF LM-ATM SUPPORT THROUGH PORT I
 - C. ATM
 - D. SLA
- III. OTHER SAVINGS
 - A. MISSION PLANNING
 - B. CREW TRAINING
 - C. MCC-H SOFTWARE
 - D. SYSTEM TEST

DECOPLED ATM MISSION

- DUAL SIVB LAUNCH
 - CM-SM FIRST
 - ATM SECOND
- CM-SM PERFORMS RENDEZVOUS AND DOCKING WITH ATM STILL IN SLA
- MINIMUM FUNCTIONS IN LM-A OR BDM
 - NO PROPULSION
 - NO GUIDANCE OR CONTROL
 - NO TELEMETRY
 - NO ACTIVE COOLING BEFORE ACTIVATION
- AAP-4 INDEPENDENT LIFE REQUIREMENT WITHIN IU LIFE
- DECOUPLED MISSION MAXIMUM DURATION
 - 28 DAYS WITH LM-ATM BECAUSE OF HABITABLE VOLUME CONSTRAINT
 - 42 DAYS WITH BDM-ATM BECAUSE OF CM-SM HYDROGEN LIMIT

I.A.

SIMPLIFICATIONS TO LM-A

I.A.1 BASELINE AAP MODS TO LM THAT DON'T HAVE TO BE MADE

- STRUCTURE
 - RCS PLUME DEFLECTORS
 - RCS MODULE SUBASSEMBLY
 - BATTERY/WATER TANK MODULE
- ENVIRONMENTAL CONTROL
 - BATTERY COLD RAILS FOR D/S BATTERY
 - LM MISSION PROGRAMMER COLD PLATES
 - ADDED (2) H₂O TANKS
 - H₂O SUBLIMATORS AND FREON BOILERS (NOT LCG SUBLIMATORS)
- REACTION CONTROL
 - SECOND RCS SHIPSET
- CREW SYSTEM
 - EXTERNAL SYSTEM STATUS LIGHTS (URD)
- INSTRUMENTATION AND COMMUNICATIONS MODS TO ONE SIGNAL CONDITIONING ELECTRONICS ASSEMBLY
 - NEW DIGITAL UPLINK ASSEMBLY
 - MODIFICATIONS TO APOLLO DIGITAL UPLINK ASSEMBLY
 - VHF COMMAND RECEIVERS
 - THREE VHF ANTENNAS
- ELECTRICAL POWER D/S BATTERIES
 - D/S ELECTRONIC CONTROL ASSEMBLY
- GUIDANCE, NAVIGATION AND CONTROL PROGRAM COUPLER ASSEMBLY
 - PROGRAM READER ASSEMBLY
 - POWER DISTRIBUTION ASSEMBLY
 - LM GUIDANCE COMPUTER MODS
 - LGC & ABORT ELECTRONICS ASSY. SOFTWARE MODS
 - DATA ENTRY & DISPLAY ASSEMBLY MODS

I.A.

SIMPLIFICATIONS TO LM-A

I.A.2 APOLLO EQUIPMENT NOT REQUIRED
CAN BE REMOVED OR OTHERWISE RENDERED INOPERATIVE

- CONTROLS AND DISPLAYS
 - FLIGHT DIRECTOR ATTITUDE INDICATOR (FFAI)
 - GIMBAL ANGLE SEQUENCE TRANSLATION ASSEMBLY
 - MAJORITY OF C&D ON MAIN AND SYSTEMS ENGINEER PANELS
 - COAS
- RCS
 - TOTAL SYSTEM
- INSTRUMENTATION AND COMMUNICATIONS
 - ENTIRE S-BAND SYSTEM
 - ENTIRE VHF SYSTEM
 - ONE SIGNAL CONDITIONING ELECTRONICS ASSEMBLY
 - SIGNAL PROCESSOR ASSEMBLY
 - APOLLO DIGITAL UPLINK ASSEMBLY
 - TWO S-BAND ANTENNAS
- GUIDANCE, NAVIGATION AND CONTROL
 - TOTAL SYSTEM
 - RENDEZVOUS RADAR AND ELECTRONIC ASSEMBLY
 - LM GUIDANCE COMPUTER
 - ATTITUDE AND TRANSLATION CONTROL ASSEMBLY
 - ABORT ELECTRONICS ASSEMBLY
 - INERTIAL MEASURING UNIT
 - DATA ENTRY AND DISPLAY ASSEMBLY

I.B.

HARDWARE RETAINED IN LM-A FOR DECOUPLED MISSION

- INDICATES AN APOLLO SYSTEM
- + INDICATES AN AAP MODIFIED OR NEW SYSTEM
- STRUCTURE
 - BASIC LM
 - + CPSM
 - + A/S ENGINE DOME COVER
 - + RADIATOR SUPPORT
 - + DOCKING TARGET
- CREW PROVISIONS
 - + ATM CONSOLE AND RESTRAINTS
 - + INTERIOR LIGHTS
 - + MAIN AND SYSTEMS ENGINEER PANELS
 - TRACKING LIGHT
 - + ATM AND CREW EQUIPMENT
- ECS
 - COOLANT SYSTEM AND COLD PLATE NETWORK
 - + RADIATOR NETWORK
 - CABIN PRESSURE CONTROL
 - OXYGEN AND WATER CONTROL
 - WATER TANKS (2)
 - + GOX ACCUMULATOR TANKS
 - + LIQUID COOLED GARMENT SUPPORT NETWORK INCLUDING SUBLIMATORS
 - + ATM C & D COLD PLATES
 - + EVA/PCU-LCG STATION
 - + HIGH PRESSURE O₂ INTERFACE WITH CM
 - + H₂O INTERFACE WITH CM
- INSTRUMENTATION AND COMMUNICATIONS
 - PCM & TIMING EQUIPMENT ASSEMBLY (NEED TIMING ONLY)
 - + CAUTION AND WARNING ELECTRONICS ASSEMBLY
 - + INTERVEHICLE SIGNAL ROUTING ASSEMBLY (LM DATA TO ATM)
 - + SIGNAL CONDITIONING AND ELECTRONICS ASSEMBLY (1 MODIFIED)
 - + LM-ATM DATA INTERFACE
 - + LM-CM BIOMED DATA, AUDIO AND C & W INTERFACE

I.B.

HARDWARE RETAINED IN LM-A FOR DECOUPLED MISSION (CONTINUED)

- ELECTRICAL POWER SYSTEM
 - A/S BATTERIES AND ELECTRONIC CONTROL ASSEMBLIES
 - TWO INVERTERS
 - + AC AND DC BUSSES
 - + RELAY JUNCTION BOX
 - + MOTOR DRIVEN SWITCHES
 - + DEAD-FACE RELAY
 - LM LIGHTING CONTROL ASSEMBLY
 - + ATM LIGHTING CONTROL ASSEMBLY
 - + LM-ATM POWER INTERCONNECTION
 - + LM-CM POWER INTERCONNECTION

I . C .

FUNCTIONS/HARDWARE REQUIRED IN BDM

- PRELIMINARY CONCEPT - BIG DUMB MODULE IS A DERIVITIVE OF THE MSFC BUILT MDA
- STRUCTURE
 - MDA TYPE WITHOUT RADIAL DOCKING PORT SECTION
 - ADD EVA HATCH
- CREW PROVISIONS
 - ATM CONSOLE AND RESTRAINTS
 - SUBSYSTEM CONTROLS AND DISPLAYS
 - INTERIOR LIGHTS
 - TRACKING LIGHT
- ECS COOLANT SYSTEM AND COLD PLATE NETWORK
 - RADIATOR
 - CABIN PRESSURE CONTROL
 - EVA/PCU-LCG STATION
 - GOX ACCUMULATOR
 - WATER TANKS
 - LIQUID COOLED GARMENT SUPPORT NETWORK INCLUDING SUBLIMATORS
 - HIGH PRESSURE O₂ INTERFACE WITH CM
 - H₂O INTERFACE WITH CM
- INSTRUMENTATION AND COMMUNICATION
 - TIMING EQUIPMENT
 - CAUTION AND WARNING
 - SIGNAL CONDITIONING
 - BDM-ATM DATA INTERFACE
 - BDM-CM BIOMED DATA, AUDIO AND C&W INTERFACE
- ELECTRICAL POWER
 - PRIMARY BATTERIES AND CONTROL ASSEMBLIES
 - INVERTERS
 - AC AND DC BUSSES
 - DEAD-FACE RELAY (POSSIBLY ATM ONLY)
 - LIGHTING CONTROL
 - SWITCHES AND RELAYS
 - BDM-ATM POWER INTERCONNECTION
 - BDM-CM POWER INTERCONNECTION

III.A.

SIMPLIFICATIONS TO AAP-3 CM-SM

III.A.1 ELIMINATE UNMANNED RENDEZVOUS AND DOCKING CAPABILITY

- ELIMINATE REMOTE TRANSLATION HAND CONTROLLER
- ELIMINATE PGNCS SOFTWARE MODS
- ELIMINATE REMOTE COMMAND SYSTEM
- COMMAND CONSOLE
- DATA ENTRY AND DISPLAY ASSEMBLY
- COMMAND PROCESSOR/FORMAT GENERATOR
- VHF TRIPLEXER MODS
- TWO VHF TRANSMITTERS AND SWITCHES
- INTERFACE TO MDA REMOTE DOCKING STATION

III.A

SIMPLIFICATIONS TO AAP-3 CM-SM

III.A.2 POSSIBLE SIMPLIFICATIONS TO CM-SM BECAUSE OF NO REQUIREMENT FOR 56 DAY COUPLED MISSION.
(THESE ARE TREATED AS MODS THAT DO NOT HAVE TO BE MADE TO BLOCK II TO SUPPORT A DE-
COUPLED ATM MISSION. THESE MODS DO HAVE TO BE MADE FOR AAP-3A, AND SAVINGS IN HARD-
WARE MIGHT BE LESS THAN THE COST OF ADDITIONAL ENGINEERING FOR TWO DIFFERENT CM-SM
CONFIGURATIONS.)

III.A.2a 28 DAY DECOUPLED MISSION WITH LM-A/ATM (VOLUME LIMITED TO 28 DAYS)

- ELECTRICAL POWER
 - DON'T REPLACE 2 PYRO BATTERIES WITH CM ENTRY BATTERY
 - DON'T ADD REDUNDANT BATTERY CHARGER
 - DON'T INSTALL RETURN BATTERY PACK (CHANGES ABORT CRITERIA)
- CRYO STORAGE
 - USE 2 RATHER THAN 3 O₂ TANKS
 - USE 2 RATHER THAN 3 H₂ TANKS (CM-SM POWER ≤ 2400 WATTS)
 - DON'T INSTALL N₂ TANKS (28 DAYS PURE O₂ OK)
- ENVIRONMENTAL CONTROL
 - DON'T MAKE 2 GAS CONTROL SYSTEM MODS
 - DON'T ADD N₂ HEAT EXCHANGER IN SM
 - DON'T ADD O₂/H₂O IVA STATION
 - DON'T MODIFY CONTROLS FOR CM COOLANT BYPASS
 - DON'T MAKE M487 WATER INTERFACE MOD
- THERMAL CONTROL
 - DON'T ADD RCS SHADOW SHIELDS
- COMMUNICATION
 - DON'T MAKE S-BAND ANTENNA SWITCHING MOD

III.A SIMPLIFICATIONS TO AAP-3 CM-SM (CONTINUED)

III.A.2b 42 DAY DECOUPLED MISSION WITH BDM/ATM

- ELECTRICAL POWER
 - DON'T INSTALL RETURN BATTERY PACK (CHANGES ABORT CRITERIA)
- ENVIRONMENTAL CONTROL
 - DON'T ADD O₂/H₂O IVA STATION
 - DON'T MODIFY CONTROLS FOR CM COOLANT BYPASS
 - DON'T MAKE M487 WATER INTERFACE MOD
- THERMAL CONTROL
 - DON'T ADD RCS SHADOW SHIELDS
- COMMUNICATIONS
 - DON'T MAKE S-BAND ANTENNA SWITCHING MOD

III.B.

SIMPLIFICATIONS TO MDA

III.B.1 ELIMINATE UNMANNED RENDEZVOUS AND DOCKING CAPABILITY

- ELIMINATE RADIAL DOCKING PORT SECTION
 - PROBE PROVISIONS
 - HATCHES
 - TUNNELS
- ELIMINATE PROBE RETRACTION CONTROLS AND DISPLAYS, WIRING AND CONNECTORS
 - ELIMINATE 12" X 17" WINDOW
- ELIMINATE COAS
- ELIMINATE TRANSLATION HAND CONTROLLER
- ELIMINATE ROTATION HAND CONTROLLER
- ELIMINATE EXTERIOR FLOODLIGHTS
- ELIMINATE CREW RESTRAINT REQUIREMENTS

III.B.2 ELIMINATE LM-ATM SUPPORT THROUGH PORT I

- ELIMINATE ECS DUCT AND FAN
- ELIMINATE HIGH PRESSURE O₂ INTERFACE
- ELIMINATE H₂O INTERFACE
- ELIMINATE ELECTRICAL POWER INTERFACE
 - CABLES
 - CIRCUIT BREAKERS
 - CONTROL SWITCHES
 - MOTOR DRIVEN SWITCHES
- ELIMINATE COMMUNICATIONS AND C&W INTERFACE

III.C. SIMPLIFICATIONS TO ATM

- ELIMINATE RUNNING LIGHTS ON OUTRIGGERS
- SIMPLIFY ATM DIGITAL AND ANALOG COMPUTERS TO CONTROL DE-COUPLED CONFIGURATION ONLY

III.D. SIMPLIFICATIONS TO SLA

- AAP-2
 - PROBLEM OF PORT 1 PROBE COVER/SLA INTERFERENCE ELIMINATED
- AAP-4
 - SIGNIFICANT PAYLOAD DECREASE PERMITS ORBIT INSERTION WITHOUT SUBORBITAL SLA JETTISON

III.

OTHER SAVINGS

SAVINGS THAT RESULT FROM REQUIREMENT TO IMPLEMENT
ONLY A DECOUPLED MISSION RATHER THAN BE ABLE TO
IMPLEMENT EITHER COUPLED OR DECOUPLED MISSIONS

- MISSION PLANNING
- CREW TRAINING
- MCC-H SOFTWARE
- SYSTEMS TEST

BELLCOMM, INC.

Subject: AAP System Simplifications Result- From: W. W. Hough
ing From Decoupling The ATM From
The Cluster

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